Investigating the resistance of a solution

In this investigation, I will be looking at the resistance of a solution, and the different things which affect it. In this experiment, I have chosen one variable, the salt concentration. I have chosen the following variables for the concentration: in a beaker of 50ml (cm) : 0 grams, 1,2,3,4 and 5 grams. Using the circuit shown below, I will find out the resistance of the salt solution. I will keep the following variables the same: I will keep the temperature at room temperature, by not changing the room temperature at all, by keeping windows shut, and not adjusting the radiators during the experiment. I will monitor the temperature, and make a note, just incase it changes. I will monitor the temperature using a thermometer, which will be placed into the beaker during each experiment. I will keep the voltage at 5V and 50cm of solution, to keep it a fair test. The circuit will include a power pack, an ammeter, a voltmeter, two iron rods, a beaker, wires with crocodile clips and a measuring tube. I will repeat each experient once, so that I can find out an average, which will prevent anomolies affecting the graph, and incase there is a difference between the first attempt, and the second attempt, I will be able to spot the mistakes.

Method

To begin with, I will place the two rods in the beaker with wires connected as shown: The ammeter is connected in series, and the voltage is measured in parallel.

Then, I will connect the circuit, shown below, and t urn the power pack on.

| | = two probes in soultion

Then I will take a note of the voltage(P.D) and the current in the circuit, using the voltmeter and the ammeter

I predict that, the more salt there is in the solution, the more current and voltage in the circuit , i.e less resistance. This is because, when there are a larger amount of irons in the solution, i.e. salt particles, the electricity will conduct better, because the electricity can pass through the solution easily, with more particles to travel across within the solution. I predict that the graph made with the results from my experiment will end in a horizontal line, this is because when more salt is added, it will no longer have any more affect on the resistance, because once a certain amount of salt is put into the solution, on adding any more, it will not dissolve, and therefore, the concentration of salt will not have been altered. This will mean that it will have no affect on the resistance, which is affected by the salt concentration.

Another thing which could affect the results, or change the experiment to show the results better, would be to use elements with a charge of 2+ and 2-, so that they will react. I am using two elements with 1+ and 1- in this experiment.

One thing which could affect the results is heat. When electricity is put through water, it creates heat. During this experiment, there is going to be heat produced. This may, or may not affect the results preceeding the experiment, because the next experiment will be performed in the same solution as the previous one, after more salt has been added. This depends on whether or not heat affects the experiment.I think that heat will affect the results, because heat will vibrate the particles around more, and therefore make them conduct electricity more, and reduce the resistance. Monitoring the temperature will mean that I can exclude heat from the list of things which may have affected the result. If the temperature remains the same, it will be helpful to my results worth.

I am going to use distilled water for this experiment. Distilled water doesn't contain any particles, or chemicals which may affect the results, which tap water would contain. If I was to use tap water, then the particles in the tap water would conduct the electricity themselves.

In this experiment, I will use a D.C supply, because I don't want the particles to be swapping charges all the time, as this may affect the results of my experiment. I want to keep the particles at a constant charge. As mentioned above, higher charges or lower charges may affect the resistance.

I will use 50cm of water, because this is quite a large amount of water, and it will allow quite a lot of salt to be dissolved into the solution.

This table shows my intensions for varying the amount of concentration, and keeping the other variables constant.

	Variable
Input	Concentration of salt
Controlled	Voltage in
	Distance between rods
	Temperature
	Wires (length, width)
Outcome	The resistance

The range of values of the concentr ation of the solution will be:

Concentration (grams per 50cm)	Percentage concentration (%)
0g	0
1g	2
2g	4
3g	6
4g	8
5g	10

I have chosen 6 values, to give a good spread of data which should give a good graph of results, because of there are more r esults, there are more correct results, and the anomolies will be easier to spot, and they wont affect the graph curve, or line as much.

Preliminary work

Before carrying out the final experiment, I tried a test experiment, to see how the experiment would work. I received the following results after setting up the circuit as explained above:

Grams of salt per 50cm	Voltage	Current	Input Voltage	Resistance
0	3.86	0.00	5	386.00
3	4.15	0.41	5	10.12
5	4.10	0.58	5	7.06

This preliminary experiment showed me that I might have to use a higher voltage, because there would be a wider range of voltage readings, and this would make a graph more easy to read and understand. I believe that

7V would be a better input voltage to have, because it is not too high, and it is not to small, as it is a higher voltage used in my preliminary work.

It shows me that 50cm is enough water to use, because it will dissolve the amount of acid I plan to use, 5g of salt. It is important that it can dissolve into the solution, because when it comes to the point when no more salt can be dissolved into the solution, it affects the results, because adding more salt has no effect on the reisistance anymore.

Apparatus

Apparatus	Use for apparatus
Power pack	To supply the power
Wires	To connect the circuit
Voltmeter	To measure the voltage
Ammeter	To measure the current
Beacker	To hold the salt solution
Rods connected to block	To keep the probes at equal distances
Crocodile clips	To connect the rods to the circuit
Measuring cylinder	To measure the water amount
Distilled water	To make salt solution

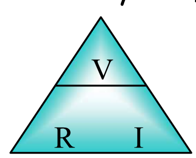
Results

Salt/g	Voltage supply	Water/ cm	Current (A)			Voltage (V)			Resistance
			First	Second	Average	First	Second	Average	
0	7	50	0.01	0.01	0.01	5.85	5.85	5.85	585.00
1	7	50	0.32	0.31	0.32	6.21	6.22	6.22	19.44
2	7	50	0.45	0.42	0.44	6.18	6.18	6.18	14.09
3	7	50	0.61	0.61	0.61	6.15	6.17	6.16	10.09
4	7	50	0.73	0.74	0.74	6.11	6.08	6.10	8.24
5	7	50	0.80	0.82	0.81	6.09	6.06	6.08	7.50

- all results to 2 d.p.
- the temperature was monitored, it did not fluctuate by more than 2'C from 22'C during the entire experiment.

Analysis

To find the resistance, I used the data I already had, the current and the voltage. I used the formula:



So the formula for finding the resistance is: $\frac{\text{Voltage}}{\text{Current}}$

The results show that the solution's concentration affects the resistance.

When there is a higher concentration of salt, there is less resistance. This is because, when salt is added to the solution, there are more salt ions within the solution, and as these conduct electicity, the increasing amount of salt ions allowed the current to flow through the solution. When there is a higher current, the resistance is lower.

As the results table shows, when there is no salt in the solution (0 grams), the resistance is 685 , however as soon as some salt is poured in, just 1 gram, the resistance gets lower by 650 . There is relatively speaking a notable difference between 0 grams and 1 gram.

The resistance by concentration graph shows a very clear curve of best fit. The curve eventually turns into a horizontal line, because adding more and more salt to the concentration will no longer affect the resistance anymore. This is an inevitable part of the graph, because when a certain amount of salt as been added to the water, there is a point when it will no longer dissolve into the solution. This is a saturated solution, this proves what was said in my prediction, which stated that the best fit line would level out into a horizontal line, when the solution becomes saturated.

Evaluation

In my experiment, I found no anomolies that stood out, just a couple of measurements which were just off of the best fit line. This lack of errors was mainly due to the fact that the voltmeter and ammeter I used were very accurate, because they were electronic instruments. This means that there was no human error involved.

I think that these results are very reliable, because they make a very good pattern. I believe that it is possible to draw a firm conclusion from these results because there are very few anomolous results. This means that unless every single result I got was a mistake, and they somehow fit a pattern, these results were very accurate.

Any anomolies which may have occurred, would be due to the small errors in measurements which may have taken place, for example in measuring water, or the salt. Even a small mistake in this could affect the resistance.

I think that this experiment could have been improved by using more variables of concentration. This would benefit the experiment because the more results there are, the better the graph and the more accurate measurements there will be.

I could vary the temperature of the experiment, my heating the beaker before carrying out the experiment, and monitoring the temperature throughout.

I would set up the circuit, as shown in my plan. Before putting the solution in a beaker, into the circuit, and placing the rods into the solution, I will heat the beaker on a tripod over a bunsen, with a thermometer in the beaker. When the temperature inside the beaker has reached the required temperature for the experiment, I will remove it from the tripod, connect the circuit, and record results. I will then rince out the beaker, and repeat the experiment again to a different temperature each time, with different temperatures.

This would show whether temperature affects the rate or not, because in my experiment, the temperature remained constant.

I could use different waters for my experiment. I used distilled water, as to not affect the results. If I was to use tapwater, I could monitor whether the particles within the tapwater affected the results or not, and whether they conduct electricity, and decrease the resistance.

I believe that the experiment would be improved, if different solutions were formed, for example, using a different material to salt, to see if this would produce the same results in terms of results.

I used a D.C supply, this was because I wanted to keep the particles at the same charge throughout the experiment, I could improve the experiment, by using an A.C current, to see if this affected the resistance.

I could use a larger amount of water,because this would enable me to dissolve more salt into the solution, and therefore give a wider spread of results.